WATER MANAGEMENT PLAN
BIG PORCUPINE CBM PROJECT
Campbell County, WY

Prepared for:

Independent Production Company, Inc.
410 17th Street, Suite 570
Denver, Colorado 80207

Prepared by:

O&G Environmental Consulting, LLC
9033 E. Easter Place, Suite 104
Englewood, Colorado 80112

December 2002

Table of Contents

Figures

Tables

Appendices

INTRODUCTION AND GEOGRAPHIC SETTING

Independent Production Company, Inc. (IPC) has proposed to develop the Big Porcupine CBM Project in Campbell County, Wyoming. The project will consist of 266 producing wells in the following locations:

T41N, R70W Section 18,
T42N, R70W Sections 5, 7 - 10, 15-22, 28-33
T41N, R71W Sections 1-4, 11-13
T42N, R71W Sections 11-14, 21-28, 32-35

The center of the project area is located approximately 15 miles southeast of Wright, Wyoming, and seven miles east of Wyoming Highway 59. The total project comprises approximately 16,480 acres, of which approximately 9,600 acres are located within the Thunder Basin National Grassland. The general location of the project area is indicated in **Figure 1**.

The project is located on the east flank of the southern portion of the Powder River Basin. The basin is an asymmetric Laramide-age structure with steeply dipping western and gently dipping eastern flanks. The basin axis trends northwest-southeast.

The project area is largely contained within the drainage of Porcupine Creek (**Figure 1** and **Project Map -** in Map Pocket), although the extreme southern part of the project area lies in the Horse Creek drainage basin and the northern part lies in the Trussler Creek - Thunder Creek drainage. All of the produced coalbed methane (CBM) water from the project is expected to be discharged within the Porcupine Creek drainage. Porcupine Creek has its confluence with Antelope Creek approximately seven miles southeast of the project area. Antelope Creek is a tributary of the Cheyenne River in northeastern Wyoming. Porcupine Creek generally flows in a northwest to southeast direction.

Data from existing CBM and coal mine dewatering wells indicate wide variability in initial water production rates. This report has assumed initial rates varying from about 3 gallons per minute (gpm) to as high as almost 30 gpm. Water production is expected to decline at approximately 50% annually.

Fig. 1 Big Porcupine CBM Project Area and Porcupine Creek Drainage Basin

The predominant land uses along Porcupine Creek in and around the project area include surface coal mining activities, coalbed methane (CBM), and conventional oil and gas operations and livestock grazing. There are three surface coal mines in the project area that will eventually move into and remove coal beneath the proposed development. These mines include the Peabody Energy (Powder River Coal Co.) North Antelope/Rochelle Complex (NARC) to the immediate southeast of the project area, the Triton Coal Company North Rochelle mine located northeast of the planned production area and the Kennecott (Antelope Coal Co.) Antelope mine located southwest of the project area.

The coal seam targeted for CBM production in the Porcupine project area is the Wyodak-Anderson seam. Depth to the target coal seam ranges from 300 to 600 feet below the surface in the project area.

WATERSHED DESCRIPTION

The Porcupine Creek drainage basin extends from headwaters in the southeastern portion of T43N, R73W, Campbell County, approximately 24 miles linearly to the southeast to the confluence of Porcupine Creek and Antelope Creek. The confluence is located in the southeastern portion of T41N, R70W, in northern Converse County. Basin elevations range from 5,200 ft. in the upper reaches, declining to 4,500 ft. at the confluence with Antelope Creek. Length of the Porcupine Creek channel is approximately 46.6 miles. The channel is well-defined and usually extensively vegetated. Episodic floods have excavated "scour" features, closed depressions within the channel floor. Configuration of the channel varies from fairly straight to highly sinuous. The channel has been periodically dammed and its lower reaches have been extensively modified by surface coal mining activities. The 60 acre Porcupine Reservoir is located approximately one mile upstream of the Antelope Creek confluence.

Porcupine Creek is an ephemeral stream throughout its length, flowing only in response to storm or snow melt runoff. The average annual precipitation for this area is approximately 11.5 inches (NOAA, 1973). Existing CBM and mine dewatering wells in the area have contributed to the natural flow. Surrounding land is typically flat to gently rolling with established dry short grasses and sage cover. Longer tributaries are well-defined, similar to Porcupine Creek, whereas shorter tributaries may be less well-defined and may be heavily grass or sage-covered.

A watershed boundary was determined for Porcupine Creek beginning at its confluence with Antelope Creek and extending to the basin divide (**Figure 1**). The watershed is 118.92 sq. miles (76,109 acres) in area and contains a number of existing stock ponds and reservoirs. Due to the large size of this watershed and the project area-specific water management issues associated with the North Antelope/Rochelle Complex coal mine, the area of project discharge within this watershed was divided into smaller sub-watersheds. The sub-watershed boundaries are indicated on the **Project Map**. The sub-watershed areas are identified by the discharge points located within them.

Subwatershed Descriptions

The drainage area of DP-24-17-41-70 is 0.23 square miles. The area has an average watershed slope of 285 feet per mile with an average channel slope of 0.030 feet per foot. Water directed to this discharge can be further diverted to DP-21-21-41-70. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-21-21-41-70 is 0.12 square miles. The area has an average watershed slope of 253 feet per mile. Discharges will flow to a pond or can be diverted to DP-24-17-41-70. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-23-19-42-70 is 1.75 square miles. The area has an average watershed slope of 238 feet per mile with an average channel slope of 0.015 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-33-20-42-70 is 0.34 square miles. The area has an average watershed slope of 227 feet per mile with an average channel slope of 0.01 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-43-28-42-70 is 0.65 square miles. The area has an average watershed slope of 275 feet per mile with an average channel slope of 0.015 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-32-29-42-70 is 1.59 square miles. The area has an average watershed slope of 238 feet per mile with an average channel slope of 0.01 feet per foot. Drainage DP-32-29-42-70 receives water from DP-33-20-42-70 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-11-30-42-70 is 1.06 square miles. The area has an average watershed slope of 312 feet per mile. Discharges will flow to a reservoir. Drainage DP-11-30-42-70 receives water from DP-23-19-42-70 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-41-33-42-70 is 0.76 square miles. The area has an average watershed slope of 121 feet per mile. Discharges will flow to a pond. Drainage DP-41-33-42-70 receives water from DP-33-20-42-70 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-21-2-41-71 is 0.43 square miles. The area has an average watershed slope of 312 feet per mile with an average channel slope of 0.005 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-34-2-41-71 is .46 square miles. The area has an average watershed slope of 354 feet per mile with an average channel slope of 0.015 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-31-11-41-71 is 0.69 square miles. The area has an average watershed slope of 211 feet per mile with an average channel slope of 0.015 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-32-21-42-71 is 5.12 square miles. The area has an average watershed slope of 253 feet per mile with an average channel slope of 0.01 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-24-23-42-71 is 1.93 square miles. The area has an average watershed slope of 211 feet per mile with an average channel slope of 0.025 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-22-26-42-71 is 2.12 square miles. The area has an average watershed slope of 528 feet per mile with an average channel slope of 0.035 feet per foot. Drainage DP-22-26-42-71 receives water from DP-24-23-42-71 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-24-26-42-71 is 18.6 square miles. The area has an average watershed slope of 222 feet per mile with an average channel slope of 0.015 feet per foot. Drainage DP-24-26-42-71 receives water from DP-31-27-42-71 and DP-32-21-42-71 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland

The drainage area of DP-34-26-42-71 is 20.2 square miles. The area has an average watershed slope of 264 feet per mile with an average channel slope of 0.015 feet per foot. Drainage DP-34-26-42-71 receives water from DP-31-27-42-71, DP-32-21-42-71 and DP-24-26-42-71 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-31-27-42-71 is 12.04 square miles. The area has an average watershed slope of 306 feet per mile with an average channel slope of 0.025 feet per foot. Drainage DP-31-27-42-71 receives water from DP-32-21-42-71 and has been included in this drainage evaluation. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-33-28-42-71 is 0.35 square miles. The area has an average watershed slope of 211 feet per mile with an average channel slope of 0.005 feet per foot. The drainage is relatively flat consisting of open rangeland.

The drainage area of DP-22-33-42-71 is 0.56 square miles. The area has an average watershed slope of 296 feet per mile with an average channel slope of 0.005 feet per foot. The proposed discharge point is located at the upstream end of a stock pond. The drainage is relatively flat consisting of open rangeland.

EXISTING, PLANNED AND POTENTIAL DISCHARGES

Produced Water – Project Related

IPC's Big Porcupine CBM Project includes 266 wells. Only one of these wells has been drilled and is located in the northeast quarter of Section 16, T42N, R70W. The estimated productive life of each well is anticipated to range from five to ten years. The life of the wells in the area closet to the coal mines is anticipated to be at the lower end of this range. Each of the wells is located on the **Project Map**. Water generated from these 266 CBM wells will be piped and pumped to 19 discharge locations also identified on the **Project Map**. Based on current information from the NARC coal mine and nearby CBM operators, water production is anticipated to be approximately 100 barrels per day (bpd), per well, for wells in the northeastern and eastern portions of the project area. CBM water production is anticipated to gradually increase across the site to 1,000 bpd per well near the northwestern portion of the project area and 750 bpd along the southwestern boundary. Typical CBM water production is expected to decline 50% per year, at least during the first year (BLM, 2002). For this study, a 50% annual water production decline has been used based on decline rates observed for other Powder River Basin CBM operations (Eastern Research Group, 2002).

The wells are indicated on the **Project Map** along with their discharge points. Buried water lines that will convey the water to the applicable discharge points are also indicated. **Appendix A** lists the 266 CBM wells, arranged by discharge point, along with estimated maximum water production. Development of the 265 new wells is expected to take approximately 16 months. Therefore, maximum water production from the project area is expected to occur within the first two years and maximum water production from individual wells will not occur at the same time. In addition to maximum CBM water production rates for each well, the calculated maximum possible added discharge rates for each discharge point are provided in **Appendix A**. Note that the maximum possible discharge for each discharge point would require all of the wells to begin production at the same time, which is unlikely. Actual maximum discharges for each discharge point will very likely be less than the listed figure.

Discharge Points

Discharge points were initially located by evaluating topographic maps, planned well locations, roads, reservoir locations and planned water use. Once these locations were established, they were inspected in the field to determine the most beneficial and stable sites. Discharge points were modified in the field based on landowner input, stability evaluations and other physiographic characteristics. The reconnaissance tour was conducted during May, 2002 by staff from IPC and O&G Environmental Consulting, LLC (O&G). Subsequently, some locations were modified or eliminated based upon onsite inspections conducted under the direction of the Forest Service in conjunction with staff from the Buffalo Field Office of the BLM during June and August, 2002.

As discussed below, CBM water produced from the Big Porcupine project area, although discharged at the facilities identified above, will be used primarily by the NARC mine for dust suppression, facilities washdown and other mining operations. NARC has purchased over twenty-one miles of pipeline to transport water as needed. Discharged water will also be used, to a lesser extent, for stock and wildlife watering. In addition, water will be diverted to landowner-requested float-valve controlled stock tanks and to a Forest Service off-channel stock pond in Section 34, T42N, R71W. CBM water discharged to the pond and stock tanks will not flow from these structures.

Each discharge point will be permitted as required through the National Pollutant Discharge Elimination System (NPDES) by the Wyoming Department of Environmental Quality (WDEQ). The location and NPDES permit option for each discharge point is indicated in **Table 1**.

Table 1
Big Porcupine CBM Project Discharge Locations

Discharge Point Name	Twp	Rng	Sect	West Longitude	North Latitude	NPDES Option	Surface Owner / Lessee
WDP 21-21-4170	41N	70W	21 NENW	105.27655	43.51652	2 - Cheyenne	Powder River Coal Co.
WDP 24-17-4170	41N	70W	17 SESW	105.29711	43.52060	2 - Cheyenne	Powder River Coal Co.
WDP 23-19-4270	42N	70W	19 NESW	105.31354	43.59916	2 - Cheyenne	Powder River Coal Co.
WDP 33-20-4270	42N	70W	20 NWSE	105.29235	43.59850	2 - Cheyenne	USFS /
WDP 43-28-4270	42N	70W	28 NESE	105.26794	43.58147	2 - Cheyenne	Powder River Coal Co.
WDP 32-29-4270	42N	70W	29 SWNE	105.29267	43.58648	2 - Cheyenne	USFS /
WDP 11-30-4270	42N	70W	30 NWNW	105.31902	43.58930	2 - Cheyenne	Powder River Coal Co.
WDP 41-33-4270	42N	70W	33 NENE	105.26683	43.57749	2 - Cheyenne	USFS /
WDP 21-2-4171	41N	71W	2 NENW	105.35676	43.56123	2 - Cheyenne	Putnam Ranch
WDP 34-2-4171	41N	71W	2 SWSE	105.34913	43.55113	2 - Cheyenne	Putnam Ranch
WDP 31-11-4171	41N	71W	11 NWNE	105.34917	43.54690	2 - Cheyenne	Putnam Ranch
WDP 34-11-4171	41N	71W	11 SWSE	105.35087	43.53575	NO NPDES	Putnam Ranch
WDP 32-21-4271	42N	71W	21 SWNE	105.38891	43.60003	2 - Cheyenne	Jerry Dilts
WDP 24-23-4271	42N	71W	23 SESW	105.35492	43.59392	2 - Cheyenne	USFS /
WDP 22-26-4271	42N	71W	26 SENW	105.35266	43.58654	2 - Cheyenne	Powder River Coal Co.
WDP 24-26-4271	42N	71W	26 SESW	105.35549	43.57962	2 - Cheyenne	Powder River Coal Co.
WDP 34-26-4271	42N	71W	26 SWSE	105.34756	43.58022	2 - Cheyenne	State Wyoming / Powder River Coal Co.
WDP 31-27-4271	42N	71W	27 NWNE	105.3698	43.59049	2 - Cheyenne	USFS /
WDP 33-28-4271	42N	71W	28 NWSE	105.39234	43.58330	2 - Cheyenne	Jerry Dilts
WDP 32-34-4271	42N	71W	34 SWNE	105.36974	43.57308	1a	USFS /
WDP 22-33-4271	42N	71W	33 SENW	105.39748	43.57227	2 - Cheyenne	Jerry Dilts
WDP 22-30-4269	42N	69W	30 SENW	105.19662	43.58772	2 - Cheyenne	USFS /

As discussed below, discharge point WDP 22-30-4269 is an emergency discharge location which is not expected to be used during the life of the project.

Water Quality

Laboratory analyses of water samples collected from CBM water in the project area are included in **Appendix B**. The analyses indicate that the coalbed methane waters within the Big Porcupine project area have lower salinity concentrations and lower sodium adsorption ratio (SAR) values than existing natural surface water. The CBM water in the project area is relatively good quality water and is suitable for livestock, wildlife, coal mine dust suppression and mining operations.

Produced Water - Non Project Related

Existing Wells

As of October, 2002, there are 51 coalbed methane wells producing from within the boundaries of the Porcupine Creek drainage according to permits filed with the Wyoming Oil and Gas Conservation Commission (WOGCC). These wells are listed in **Table 2**. Sixteen of the wells, operated by Continental Industries, LC, are located in Section 36, T42N, R71W. These wells all have first production dates indicated as March 15, 2002. Average initial water production was 320 bpd per well. These wells are situated immediately adjoining the eastern boundary of the central portion of the project area.

Eight producing wells are located within the Porcupine Creek drainage basin immediately adjoining the western boundary of the central portion of the project area. The wells are operated by Merit Energy Corporation and are situated in Section 16, T42N, R71W. These wells have first production dates of November and December, 2001. As of August, 2002, the wells have produced a cumulative 1,729,473 barrels of water.

Prima Oil and Gas Co. operates eight wells in Section 7, T42N, R71W near Porcupine Creek and northwest of the project area. The wells came on production in July, 2002, and as of August, 2002 had produced a cumulative 316,203 barrels of water. Prima also operates eight wells in Sections 12 and 13, T42N, R72W. These well began production in July and August, 2002, and as of August, 2002 have produced a cumulative 279,266 barrels of water.

In Section 36 of T42N, R72W, three wells belonging to Bowers Oil and Gas, Inc. (of eight in the section) are located within the very southern limit of the Porcupine Creek basin. Data from the WOGCC show these as producing wells with first production dates in 1997 or 1999. No gas production has been reported. As of March, 2002, the wells have produced a cumulative 5,528,493 barrels of water. All produced water from these wells has been contained within a natural playa with no overflow into either Porcupine Creek or Horse Creek.

Table 2
Producing CBM wells, Porcupine Creek drainage basin (Wyoming Oil and Gas Conservation Commission data as of 10/2002)

API #	Company	Well Name	Section	Qtr/Qtr	Status	Latitude	Longitude	Township	Range	First Prod.
49-005-39729	PRIMA OIL & GAS COMPANY	DILTS 4271-7-24UW	7	SE NW	FL	43.63018	105.43551	42N	71W	7/2/02
49-005-39730	PRIMA OIL & GAS COMPANY	DILTS 4271-7-23UW	7	SW NW	FL	43.63023	105.44061	42N	71W	7/2/02
49-005-39731	PRIMA OIL & GAS COMPANY	DILTS 4271-7-22UW	7	NW NW	PS	43.63381	105.44062	42N	71W	7/2/02
49-005-39732	PRIMA OIL & GAS COMPANY	DILTS 4271-7-13UW	7	SW NE	FL	43.63014	105.43007	42N	71W	7/2/02
49-005-39860	PRIMA OIL & GAS COMPANY	DILTS 4271-7-43UW	7	SW SE	FL	43.62291	105.43012	42N	71W	7/2/02
49-005-39861	PRIMA OIL & GAS COMPANY	DILTS 4271-7-34UW	7	SE SW	FL	43.62294	105.43516	42N	71W	7/2/02
49-005-39863	PRIMA OIL & GAS COMPANY	DILTS 4271-7-32UW	7	NW SW	FL	43.62663	105.44059	42N	71W	7/2/02
49-005-39864	PRIMA OIL & GAS COMPANY	DILTS 4271-7-42UW	7	NW SE	FL	43.62657	105.4301	42N	71W	7/2/02
49-005-42239	MERIT ENERGY COMPANY	STATE CBM 43-16	16	NE SE	FL	43.61207	105.38487	42N	71W	11/1/01
49-005-42240	MERIT ENERGY COMPANY	STATE CBM 41-16	16	NE NE	FL	43.61957	105.38531	42N	71W	12/1/01
49-005-42241	MERIT ENERGY COMPANY	STATE CBM 34-16	16	SW SE	FL	43.60869	105.38985	42N	71W	11/1/01
49-005-42242	MERIT ENERGY COMPANY	STATE CBM 32-16	16	SW NE	FL	43.61596	105.39032	42N	71W	12/1/01
49-005-42243	MERIT ENERGY COMPANY	STATE CBM 23-16	16	NE SW	FL	43.61191	105.39484	42N	71W	11/1/01
49-005-42244	MERIT ENERGY COMPANY	STATE CBM 21-16	16	NE NW	FL	43.61963	105.395	42N	71W	12/1/01
49-005-42245	MERIT ENERGY COMPANY	STATE CBM 14-16	16	SW SW	FL	43.60846	105.40035	42N	71W	12/1/01
49-005-42246	MERIT ENERGY COMPANY	STATE CBM 12-16	16	SWNW	FL	43.61601	105.40035	42N	71W	3/1/02
49-005-46529	CONTINENTAL INDUSTRIES LC	STATE 44-36	36	SE SE	PS	43.56499	105.325	42N	71W	11/1/02
49-005-46530	CONTINENTAL INDUSTRIES LC	STATE 43-36	36	NE SE	PG	43.56889	105.32472	42N	71W	3/15/02
49-005-46531	CONTINENTAL INDUSTRIES LC	STATE 42-36	36	SE NE	PG	43.57222	105.32472	42N	71W	3/15/02
49-005-46532	CONTINENTAL INDUSTRIES LC	STATE 41-36	36	NE NE	PG	43.57611	105.32472	42N	71W	3/15/02
49-005-46533	CONTINENTAL INDUSTRIES LC	STATE 34-36	36	SW SE	PG	43.56555	105.32971	42N	71W	3/15/02
49-005-46534	CONTINENTAL INDUSTRIES LC	STATE 33-36	36	NW SE	PG	43.56861	105.32971	42N	71W	3/15/02
49-005-46535	CONTINENTAL INDUSTRIES LC	STATE 32-36	36	SW NE	PG	43.57222	105.32917	42N	71W	3/15/02
49-005-46536	CONTINENTAL INDUSTRIES LC	STATE 31-36	36	NW NE	PG	43.57639	105.32944	42N	71W	3/15/02
49-005-46537	CONTINENTAL INDUSTRIES LC	STATE 24-36	36	SE SW	PS	43.56499	105.33472	42N	71W	3/15/02
49-005-46538	CONTINENTAL INDUSTRIES LC	STATE 23-36	36	NE SW	PG	43.56861	105.33499	42N	71W	3/15/02
49-005-46539	CONTINENTAL INDUSTRIES LC	STATE 22-36	36	SE NW	PG	43.57249	105.33472	42N	71W	3/15/02
49-005-46540	CONTINENTAL INDUSTRIES LC	STATE 21-36	36	NE NW	PG	43.57611	105.33499	42N	71W	3/15/02
49-005-46541	CONTINENTAL INDUSTRIES LC	STATE 14-36	36	SW SW	PG	43.56499	105.33972	42N	71W	3/15/02
49-005-46542	CONTINENTAL INDUSTRIES LC	STATE 13-36	36	NW SW	PG	43.56861	105.33972	42N	71W	3/15/02
49-005-46543	CONTINENTAL INDUSTRIES LC	STATE 12-36	36	SW NW	PG	43.57278	105.33944	42N	71W	3/15/02
49-005-46544	CONTINENTAL INDUSTRIES LC	STATE 11-36	36	NW NW	PG	43.57611	105.33972	42N	71W	3/15/02

49-005-39726	PRIMA OIL & GAS COMPANY	DILTS 4272-12-44UW	12	SE SE	FL	43.62302	105.4456	42N	72W	8/2/02
49-005-39739	PRIMA OIL & GAS COMPANY	DILTS 4272-12-41UW	12	NE SE	FL	43.62668	105.4456	42N	72W	8/2/02
49-005-39740	PRIMA OIL & GAS COMPANY	DILTS 4272-12-42UW	12	NW SE	PS	43.62674	105.45063	42N	72W	8/2/02
49-005-39741	PRIMA OIL & GAS COMPANY	DILTS 4272-12-43UW	12	SW SE	PS	43.62307	105.45063	42N	72W	8/2/02
49-005-43902	PRIMA OIL & GAS COMPANY	DILTS 4272-12-11UW	12	NE NE	FL	43.63418	105.44598	42N	72W	7/2/02
49-005-43901	PRIMA OIL & GAS COMPANY	DILTS 4272-12-13UW	12	SW NE	PS	43.63013	105.45076	42N	72W	8/2/02
49-005-43668	PRIMA OIL & GAS COMPANY	DILTS 4272-12-23UW	12	SW NW	PS	43.63082	105.46066	42N	72W	8/2/02
49-005-42081	PRIMA OIL & GAS COMPANY	DILTS 4272-13-41UW	13	NE SE	FL	43.61276	105.44589	42N	72W	7/2/02
49-005-33192	BOWERS OIL & GAS INC	BOG STATE 7-36	36	NE NE	PS	43.57585	105.44767	42N	72W	1/9/99
49-005-33193	BOWERS OIL & GAS INC	BOG STATE 8-36	36	NW NE	PS	43.56506	105.45233	42N	72W	1/9/99
49-005-31826	BOWERS OIL & GAS INC	BOG STATE 5-36	36	SE NE	PS	43.57219	105.44542	42N	72W	10/17/97
49-005-31711	BOWERS OIL & GAS INC	BOG STATE 2-36	36	NW SE	PS	43.56869	105.44989	42N	72W	6/17/97
49-005-31712	BOWERS OIL & GAS INC	BOG STATE 3-36	36	SE SE	PS	43.56508	105.44472	42N	72W	1/9/99
49-005-46149	YATES PETROLEUM CORPORATION	COSNER CS 3	19	NE NW	FL	43.69082	105.55556	43N	72W	6/2/02
49-005-46145	YATES PETROLEUM CORPORATION	COSNER CS 7	19	NE NW	FL	43.69084	105.55556	43N	72W	6/2/02
49-005-41607	YATES PETROLEUM CORPORATION	CHIP CS 1	24	NE SE	FL	43.68361	105.56556	43N	73W	8/16/00
49-005-41606	YATES PETROLEUM CORPORATION	DIANNA CS 1	25	NE NE	FL	43.67667	105.56528	43N	73W	8/21/00
49-005-41604	YATES PETROLEUM CORPORATION	DEAN CS 1	25	NE SE	FL	43.66899	105.56556	43N	73W	8/9/00
49-005-41605	YATES PETROLEUM CORPORATION	COLT CS 1	35	NE NE	FL	43.66194	105.58583	43N	73W	8/21/00

Data from the Wyoming State Engineer's Office (WSEO) indicate that as of October, 2002, 382 wells are currently actively permitted for CBM water discharge within the Porcupine Creek basin. These wells are listed in **Appendix C**.

Potential Development

The proposed project is located near the southeastern limit of current CBM exploration in the Powder River Basin. Examination of WOGCC well permit data in a nine township area in the vicinity of the project (T41N, R71-72W; T42N, R70-72W; and T43N, R70-73W) lists 888 active, producing, or pending well permits as of June, 2002. Over the same area, data from the WSEO indicates 699 active CBM water well permits. There is little doubt, barring a dramatic change in the economics of CBM development, that most of the area surrounding the project will be drilled in the near future.

Outcrops of the producing coals and active coal mining to the southeast of the project area define a limit beyond which CBM development is unlikely. The area of the Porcupine Creek basin with high probability of CBM development equals 90.93 square miles (58,192 acres).

CBM operators have received or are expected to receive an exception drilling spacing of 40 acres per well from the WOGCC near the existing coal mines to minimize drainage from the mine high wall and maximize gas removal prior to mining. Over the vast majority of the potential development area, it is assumed that drilling spacing will be 80 acres in accordance with default spacing rulings of the WOGCC.

Based on an existing development area of 4.81 sq. miles and the Big Porcupine project area of approximately 25.75 sq. miles, the total area of existing development and planned development from the project is approximately 30.56 sq. miles. This leaves an undeveloped area of the developable portion of the Porcupine drainage basin of 60.37 sq. miles. At a fully drilled density of 8 wells per section, ultimate CBM development in the Porcupine basin is projected to be an additional 483 wells. Maximum ultimate development would thus be:

Existing CBM wells:	50
Big Porcupine project wells:	266
Maximum future development wells:	483
Total maximum wells, ultimate development:	**799**

DISPOSITION OF PRODUCED WATER

Storage Reservoirs

Produced CBM water will be discharged into various drainages adjacent to the discharge points. All but one of the drainages identified in the project area naturally flow to, or will be pumped to, several reservoirs constructed by the North Antelope/Rochelle Complex coal mine. These reservoirs have been designed to collect water for flood control and for use in mining operations (NARC, 2002). The reservoirs have been permitted, as necessary by the WSEO, Army Corps of Engineers (USACOE) and other agencies. The major reservoirs are listed in **Table 3** and are described below. NARC also has numerous other reservoirs to facilitate water management within the mine. North Antelope/Rochelle Complex has obtained over 21 miles of HDPE pipe to ensure it can move water between reservoirs for use in its mining operations.

Because industrial water use is a significant expense for NARC, the mine is working with several CBM operators to obtain discharge water. IPC has an agreement with NARC that states that IPC will have first call on storage in the mine reservoirs (Independent Production Company/Powder River Coal Company, 2002).

Table 3
Major North Antelope/Rochelle Complex Flood Control Reservoirs in the Project Area

Reservoir Name	Location	Date Built	Total Capacity (ac-ft)	Available CBM Capacity (ac-ft)*	Available CBM Capacity (bbls)*	Area (ac)	Estimated Annual Evaporation & Infiltration Loss **	
							Ac-ft	Bbls
Wilkinson	26-42-71	2002	240	0	0	73	0	0
Boss Draw	30-42-70	2002	275	60	465,502	27.2	299	2,321,304
North Corder Creek	29-42-70	2001	81	20	155,167	9.7	107	827,818
New Payne	33-42-70	2001	170	65	504,294	15.9	175	1,356,939
Shop	21-41-70	1982	15	0	0	1.8	0	0
2B	21-41-70	2001	11	0	0	2.2	0	0
Totals			792	145	1,124,963	52.8	581	4,506,061

* Available Capacity is that above what would be expected from a 100 yr./24hr. storm event.
** Assumes 6"/month evaporation 10 months/yr (2 months frozen over) and 6"/month infiltration 12 months/yr., or 11' losses annually.

The primary purpose of these reservoirs is to protect the mine from flooding associated with 100 yr./24 hr. storm events to the north. The reservoirs also enable NARC to collect stormwater and CBM water for mining operations. CBM water may occasionally be discharged to the Shop and 2B Reservoirs. Unlike the other reservoirs in **Table 3**, these function as water supply sources. Discharges to these water supply source reservoirs are not anticipated to involve large quantities of water and may be sporadic.

The bulk of project produced water (12 of 22 discharge points) will be discharged to tributaries of Porcupine Creek or to Porcupine Creek directly. Produced water from most of the southern and western portions of the project area will be handled through these channels. All of the flow from these areas will ultimately be collected into a large (100 acre-feet) reservoir, designated here as the Mine Collection Reservoir, in NW SE of Section 36, T42N R70W. From this point, NARC has established pipelines to pump water successively (west to east) to the Boss Draw, North Corder Creek, and New Payne flood control reservoirs.

The Wilkinson Reservoir flood control structure will provide protection to the mine from large storm events on the upstream sections of Porcupine Creek. Water in the creek will flow from the Wilkinson reservoir through the slidegate to Section 36 east to the Mine Collection Reservoir.

Until Section 36 is mined through, only periodic collection of water from major storm events is planned for Wilkinson Reservoir. Following mine-through of Section 36, the slidegate will be closed and any accumulated water will be pumped directly to Boss Draw Reservoir. No storage of CBM produced water is therefore planned for Wilkinson Reservoir.

Boss Draw Reservoir, planned for construction in late 2002, will be the largest of the flood control structures along the north side of the mine (275 acre-feet). Capacity built above the 100 yr. flood criteria will permit storage of up to 60 acre-feet (465,000 barrels) of CBM water. The reservoir will be the main collection and transfer point for water in the northwest portion of the mine as it acts as a recipient for water pumped from the Mine Collection Reservoir. Water from the Boss Draw impoundment will be pumped about one mile east to the North Corder Creek Reservoir. In addition to flood discharge in Boss Draw, the structure will receive CBM water from two discharge points located, respectively, adjacent to the reservoir and upstream on Boss Draw.

The North Corder Creek Reservoir was constructed in 2001 to provide flood control for Corder Creek and to divert CBM water from two discharge points located upstream. Other CBM water may be pumped from Boss Draw Reservoir to the west. The North Corder Creek Reservoir was designed to hold 20 acre-feet above the 100 yr./24 hr. storm event. This capacity would be used for CBM water. In addition, the reservoir is classified as an incised structure under Mine Safety and Health Administration (MSHA) regulations and there is another flood control impoundment located between the reservoir and the mine. This gives NARC the option of storing water up to the high water line of the reservoir. Up to 61 acre-feet (473,000 barrels) of CBM water could potentially be stored at North Corder Creek (Murphree, 2002). Water from the North Corder Creek Reservoir will be pumped east to the New Payne Reservoir.

New Payne Reservoir was constructed in 2001 with a total capacity of 170 acre-feet. Available capacity for CBM water storage above the 100 yr./24 hr. storm event is 65 acre-feet (504,000 barrels). In addition to water from North Corder Creek Reservoir, the impoundment will receive CBM water from two discharge points adjacent to and upstream of the structure. New Payne Reservoir will pump water south and east to the KPD#2 Reservoir for use in the mine. Within the mine, there are a number of water supply and sediment control reservoirs that could be used for CBM produced water storage. A number of these reservoirs are listed in **Table 4**. Total storage capacity within the mine is approximately 253 acre-feet (1,963,000 barrels), although not all of this storage capacity may be available for CBM use at any one time.

Table 4
North Antelope/Rochelle Complex Water Supply Reservoirs

Name	Constructed	Capacity (ac-ft)	Capacity (bbls)	Mine Pits Served	Type
5A-1	1996	21	162,925	West-Middle	Sediment/Water Supply
Big J	2001	56	434,469	West-Middle	Water Supply
Mad Ferret	2001	12	93,095	West-Middle	Water Supply
KPD-1	1995	68	527,564	Middle-North	Water Supply
KPD-2	1996	61	473,255	North-East	Water Supply
F.S. No. 2	2002	~20	155,183	East	Sediment/Water Supply
Ramp 1 Sump	1993	~15	116,359	West-Middle	Water Supply
Totals		253	1,962,850		

Water discharged in Sections 17 or 21, T41N R70W will either flow to the stock watering reservoirs in Section 20 or will be diverted to the water supply reservoirs (2B and Shop) located in Section 21 for use in the mine for dust suppression.

Contingency Discharge Point

A water balance of CBM water production and mine usage is discussed below. Based upon this study, it appears that all of the water produced by IPC during the Big Porcupine project can be successfully managed by the NARC mine. As a contingency, should the mine meet its storage capacity and be unable to take IPC's CBM water, water may be pumped from the New Payne Reservoir to a discharge point located in Section 30, T42N R69W on an unnamed tributary of School Creek, a tributary of Little Thunder Creek. Project discharge of water to this site is highly unlikely but will be permitted as required by WDEQ. Discharge of Porcupine Creek basin water to the Little Thunder Creek basin is allowed by WDEQ because both streams have the same classification and both flow to Antelope Creek.

Beneficial Use of Produced Water

As previously noted, quality of CBM produced water is relatively good in the project area with lower salinities and SAR values than natural water in the vicinity. Each of the 19 planned discharge points will be equipped with a small stock tank for livestock use and the overflow piped to a nearby outfall structure. Additional stock tanks, equipped with float-controlled shutoff valves, may be installed at the request of local landowners. The latter stock tanks will not discharge water to any drainage. The U.S. Forest Service has also requested discharge to a closed, off channel basin in SW NE Section 34, T42N R71W, which will be used for stock or wildlife watering.

The bulk of water produced incidentally to CBM development will be used for industrial purposes. The large NARC surface coal mine requires large amounts of water for dust suppression, facilities washdown, reclamation efforts, and release to downstream users. Significant amounts of water are lost from mine reservoirs through infiltration and evaporation. Water requirements vary considerably by season, with highest usage (up to and exceeding 100,000 barrels/day) from May through August. During the months of December through February, requirements may be less than 40,000 barrels/day. Lowest usage has been recorded in February, with an average daily use of 31,405 barrels (Murphree, 2002a). Continued expansion of the mine accompanied by an increase in haul road length suggests that NARC will require increasing amounts of water in the future. A summary of mine usage by month for various purposes is indicated in **Table 7**, below.

Produced Water Conveyance Losses

Loss of produced CBM water occurs from infiltration into the subsurface and through evapotranspiration. Losses occur both within storage reservoirs and along discharge channels.

Anecdotal evidence from CBM operators in the Powder River Basin suggests that water losses can be significant.

Data from the NARC coal mine provide good estimates for water loss from reservoirs (Murphree, 2002a, 2002b). Infiltration losses have been determined to average 6 inches/month. Evaporation losses vary somewhat seasonally, but are also very close to 6 inches/month, with the exception of winter periods when the reservoirs are frozen over. For this study, reservoir freezing has been assumed to occur during two months of the year. Total infiltration and evaporation losses from reservoirs are thus calculated to be 11 feet annually. The mine's infiltration numbers are actually less than those cited in the Powder River Basin Oil and Gas Project Draft EIS (BLM, 2002), which estimates infiltration losses at eight feet annually for impoundments designed to allow leakage.

Data on CBM water conveyance losses within drainage channels has been more difficult to obtain. Ideas relating to the amount of conveyance loss have changed dramatically since the onset of the CBM development boom in the Powder River Basin. Estimates of channel conveyance losses by the Wyoming Board of Control cited in the Wyodak Coal Bed Methane EIS were figured to be 1%/mile, of which only 20% was assumed to result from infiltration (BLM, 1999). In a very short time, however, field experience resulted in changed perceptions. Specific predictions of conveyance losses were not made in the Wyodak Drainage Coal Bed Methane EA (BLM, 2000). However, discussion of water loss in that document noted that the projected volumes of produced CBM water were less than volumes expected in the EIS. In addition, field observations had been made on streamflows in CBM discharge channels in the Belle Fourche drainage basin during 1997-1999 and in the Little Powder River drainage (Meyer, 2000, 2002). These studies indicated that little or none of the CBM discharge was reaching stream gaging stations. Particularly during periods of low precipitation, total CBM losses were projected to be up to or greater than 90%. Meyer noted that "streamflow conveyance losses have been significantly greater than predicted."

Because accurate knowledge of the ultimate disposition of produced water is critical to analyzing environmental effects of CBM development, an effort has been made to quantify conveyance losses in the Powder River Basin Oil and Gas Project Draft EIS (BLM, 2002). In that document, conveyance losses have been estimated to be 80% of the produced water, of which 82% of the total loss is due to infiltration and 18% to evapotranspiration. Estimates are based upon recent studies in several Powder River Basin drainages which exhibited losses of 64%-100% during dry weather. According to Paul Beels, BLM Project Manager for the EIS, the final version of the EIS will also cite the above estimates on conveyance loss. Beels believes that the best science supports these estimates (Beels, 2002).

Hydrologic modeling for the EIS has been conducted by Applied Hydrology and Associates (AHA). According to Mike Day, hydrologist for AHA, the conveyance losses noted in the EIS have not been measured over specific channel lengths or distances, but have grouped releases from multiple discharge points. He notes, however, that typical distances involved were "two to three miles" (Day, 2002). Based on an average discharge length from the above studies of 2.5 miles, calculated total conveyance loss is 47.5%/mile of channel. This value has been used to estimate the produced water losses from the point of discharge to the mine reservoirs.

Produced Water / Mine Usage Water Balance

The exact order in which individual CBM wells will be drilled within the Project area is highly uncertain, depending upon economics, rig availability, timing of the authorization to proceed from the Forest Service, and biological timing restrictions. Because projected water production rates vary considerably across the project area, the volumes of produced water expected at any particular time after drilling startup may be highly dependent on drilling order and intensity. Based upon information obtained from IPC, this report has assumed that all of the project wells will be drilled over a 16 month period.

Two scenarios have been tested. The "typical" case involves a drilling schedule which would tend to maximize recovery of gas from areas of high drainage near the active mine high wall. To test the sensitivity of water production to the drilling schedule, a second "maximum flow" case was calculated. In this scenario, it was assumed that wells would be drilled in order of projected water production, i.e., highest water producing wells would be drilled first and lowest water producers would be drilled at the end of the 16 month drilling time frame. This scenario allows IPC the greatest drilling flexibility in that, regardless of drilling order, any schedule should produce a flow burst lower than the "maximum flow" case. Monthly gross water production volumes were computed for each case.

To determine the effects of conveyance losses on the volumes of water reaching storage reservoirs, channel lengths were measured from each of the 19 discharge points to their storage reservoirs. A value of 48%/mile conveyance loss was assumed, based upon the data obtained from the Powder River Basin Oil and Gas Project Draft EIS and personal consultations (Day, 2002; Beels, 2002). Because channel lengths differ among the discharge points, the percentage of water reaching each reservoir was computed for all the discharges. Monthly net water production volumes were then calculated for each discharge point based upon the loss percentages at the reservoirs. In addition, because of concerns about erosive effects from CBM discharge to an area of significant channel headcutting in an unnamed Porcupine Creek tributary in Section 27, T42N R71W, gross and net water volumes were also computed to determine how much water would reach this area.

Gross water production from the typical case is illustrated in **Appendix D**, and from the maximum flow case in **Appendix E**. The net water volumes produced under the typical case scenario are illustrated in **Table 5**. Similar data for the maximum flow case are illustrated in **Table 6**. These data suggest that drilling order has little effect on the maximum volumes of water produced. Under the typical case, maximum daily output (91,000 gross BWPD, 22,000 net BWPD) occurs 15 months after the start of production. The peak gross number for the typical case actually exceeds the maximum value (88,000 gross BWPD) derived from the maximum flow scenario, reached in month 11. Under the maximum flow case, maximum net production is delayed until month 14 (24,700 net BWPD). The major differences between the two scenarios is that under the maximum flow case, water production builds and peaks more rapidly than for the typical case. Both scenarios show gross production declining at similar rates.

Table 5: CBM Net Produced Water after conveyance losses

Table 5 page 2

Table 5 page 3

Table 6 CBM Net Produced Water after Conveyance Losses - Maximum Flow Case

Table 6 page 2

Table 6 page 3

Net production curves mimic the gross production curves for each scenario, except that the net production under the maximum flow case does not build as quickly as does gross production. As was the situation with gross production figures, the maximum net production values are similar, although slightly higher for the maximum flow scenario. Both cases reach a maximum production value slightly less than, or in the range of, 90,000-95,000 gross BWPD. Production declines are rapid, with gross production levels of half the maximum values being reached within 14-15 months following peak output. These data suggest that maximum water production volumes are largely independent of drilling order and indicate that flexibility in the drilling schedule will not result in unexpectedly large volumes of water being produced.

Of equal importance, the data indicate that maximum net volumes of produced water will be less than minimal mine requirements, regardless of the timing of the drilling schedule. Peak net volumes of 22,024 BWPD (typical case) and 24,720 BWPD (maximum flow case) are less than the minimum mine requirements of 31,405 BWPD during the month of February. This means that the NARC coal mine is easily capable of handling produced water volumes and indicates the very low probability of releases from the contingency discharge point on the tributary to School Creek. A summary of the mine water use data, compared to peak CBM production values, is illustrated in **Table 7**. These data are graphically represented in **Figures 2** and **3**.

As a final check, sensitivity testing was conducted to determine the effects of varying the assumed conveyance loss rate. At any rates above 35%/mile (for the typical case) and 38%/mile (for the maximum flow case), maximum net volumes of produced water are less than minimal mine requirements. Even at conveyance loss rates as low as 25%/mile, mine requirements are exceeded only minimally for a 9-11 month period. Under that scenario, mine reservoir storage capacity is sufficient to handle the excess water.

HYDROLOGIC WATERSHED ANALYSIS

The unnamed tributaries to Porcupine Creek are ephemeral streams which flow only in direct response to precipitation and snowmelt. Runoff volumes and peaks from ephemeral streams are dependent on precipitation frequency-duration relationships and on the characteristics of the contributing drainage areas. The factors that control precipitation runoff characteristics are area, slope, soil type, vegetative cover and stream length.

The Porcupine Creek watershed was evaluated from the confluence with Cripple Creek in Section 18, T. 42N., R. 71W to a point upstream of the north edge of Section 21, T. 41 N., R. 70 W. This is a large area (more than 35,000 acres), but the watershed of Porcupine Creek extends a number of miles farther to the northwest.

While it would be ideal to evaluate the entire Porcupine Creek watershed to estimate storm flows, it is reasonable to assume that in Wyoming a 24-hour storm event would be unlikely to cover the entire Porcupine Creek watershed with the amount of precipitation expected during such events. Therefore, the estimated peak discharges for the main channel of Porcupine Creek at the bottom-most point (north edge of Section 21) may not be greatly underestimated.

Table 7: North Antelope/Rochelle Complex Mine Water Usage (1 page)

Figure 2.
Big Porcupine CBM Water Production - Typical Flow Case

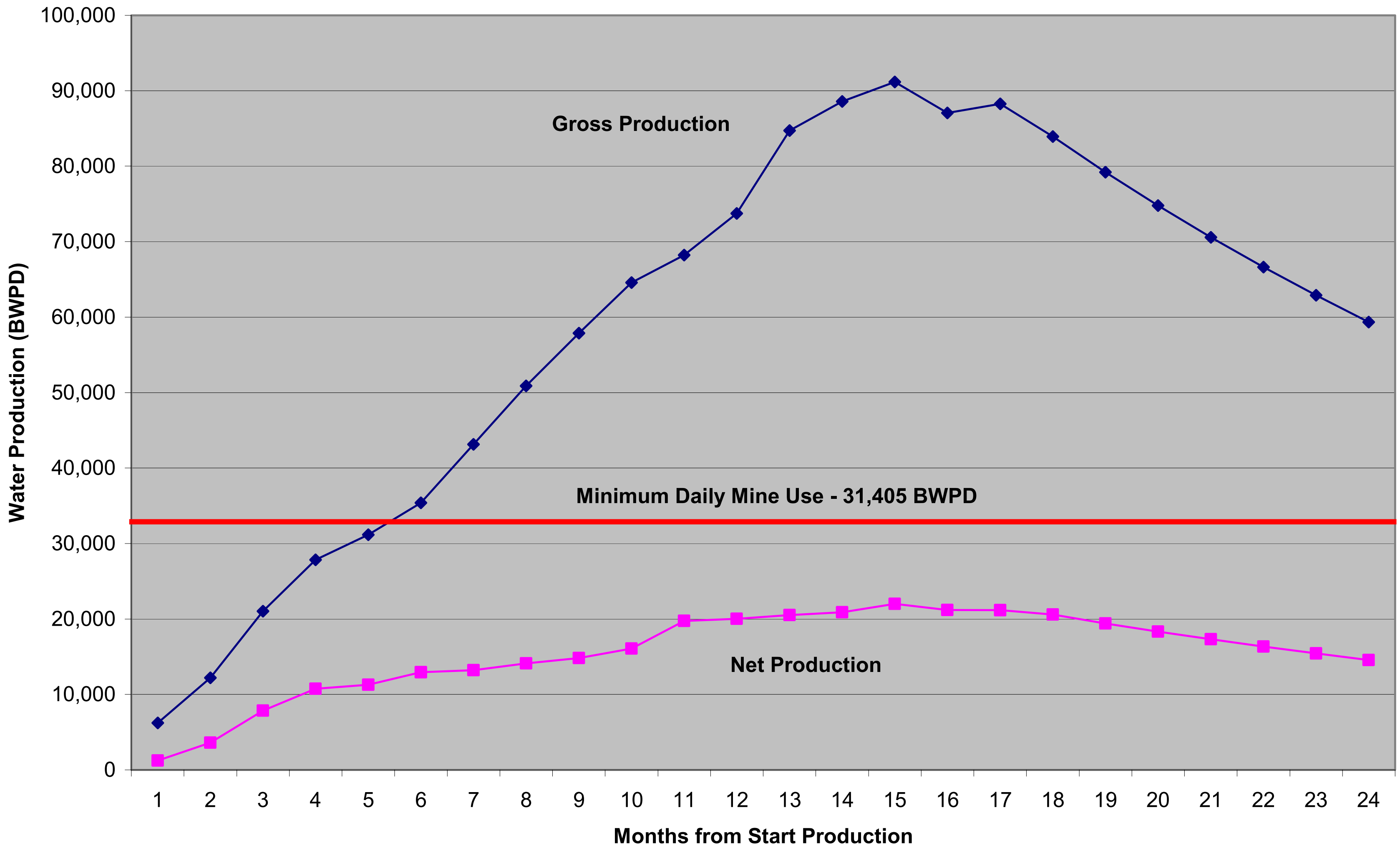
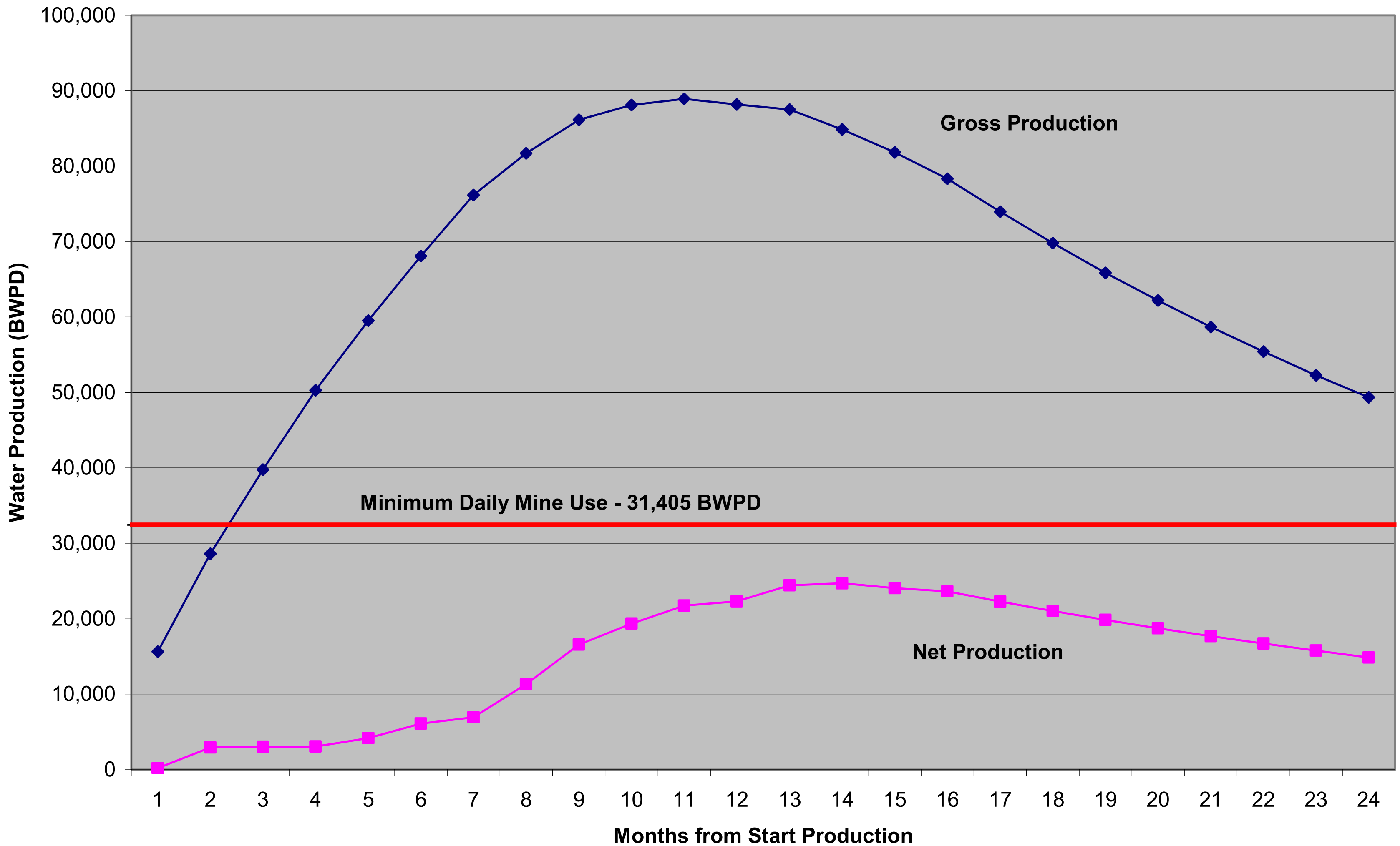


Figure 3.
Big Porcupine CBM Water Production - Maximum Flow Case



The 19 active stream discharge points were located on several USGS 7 ½ minute maps and sub-watershed areas were defined. The area of each sub-watershed and the length of the longest watercourse within each sub-watershed was measured using a digital planimeter (this was also done for the main channel of Porcupine Creek within the area of evaluation that was outside of the discharge point sub-watersheds). The elevation difference along the longest watercourse in each sub-watershed was determined and the average slope of each sub-watershed was calculated by breaking each sub-watershed into 1/3 mile squares, then measuring, in a direction perpendicular to the contour lines, the distance and the elevation drop across each square. The slopes for all of the squares in each sub-watershed were then averaged.

Field data such as bank width, channel depth, channel condition, site activity (usually cattle), ground cover type and percent ground cover were documented during preliminary site inspections of the discharge points. This information was used to determine channel area, evaluate potential impacts to the channel and calculate peak flows.

The NOAA Atlas for Wyoming was used to find values of expected precipitation for 2-year, 5-year, 10-year, 25-year, 50-year and 100-year 24-hour storm events in the vicinity of Porcupine Creek. Precipitation values associated with recurrence interval periods were used to calculate surface runoff quantities. Precipitation frequency values are listed in **Table 8**.

Table 8
Precipitation Frequencies

Recurrence Interval (yr)	Storm Duration (hr)	Precipitation (in)
2	24	1.3
5	24	1.7
10	24	2.1
25	24	2.5
50	24	2.8
100	24	3.2

The Campbell County, Wyoming SCS Soil Survey map was used for the project area to determine the hydrologic soil group for each sub-watershed. In general, most of the site has soils with low infiltration rates, with a few areas of very low infiltration rates.

The SCS Engineering Field Manual for Conservation Practices, Chapter 2 - Estimating Runoff (USDA, 1984) was used to calculate peak discharges for the 2-year, 5-year, 10-year, 25-year, 50-year and 100-year 24-hour storms. This method is intended for watersheds of less than 2,000 acres and was applied uniformly for all of the sub-watersheds. Three of the sub-watersheds on Porcupine Creek are larger than 2,000 acres (the largest being 4,400 acres). However, given that the three larger sub-watersheds are fairly uniform in terms of hydrologic soil group and slope, the derived runoff values are reasonable.

Peak discharges were calculated using derived runoff curve numbers. Curve numbers are provided in the SCS manual and are based on hydrologic soil group, vegetative cover type and hydrologic condition (percent ground cover and site activity, such as grazing). Using the curve number and precipitation amount for each storm event, the amount of direct runoff generated by each storm can be determined from the graph provided in the SCS manual. The average minimum infiltration loss was then calculated by subtracting runoff from precipitation.

The time it takes for runoff to travel from the hydraulically most distant point of the sub-watershed to the discharge point was also calculated. This is known as the time of concentration. The time to peak discharge for each sub-watershed was calculated using the SCS relationship for these two parameters. Using the known length of the longest watercourse, the average watershed slope and the curve number, the concentration for each sub-watershed was determined. For each storm event, the unit peak discharge can then be derived graphically by knowing the curve number, precipitation amount and time of concentration. This relationship is based on the intensity of rainfall, which is rated by the SCS in terms of climatic region. Most of the U.S., including Wyoming, is within the Type II storm distribution area (more intense).

Using unit peak discharge, sub-watershed area and the runoff values for each storm event, the peak discharge was calculated (in cubic feet per second) for the 2-year, 5-year, 10-year, 25-year, 50-year and 100-year storms for each sub-watershed. Some of the sub-watersheds are on the same tributary to Porcupine and include parts of the same sub-watershed area; in such cases, peak discharges were added together to provide the total peak discharge at certain discharge points. For the entire Porcupine Creek watershed (as defined above), the peak discharges of all the sub-watersheds within the Porcupine Creek watershed were added to the peak discharges calculated for the area between the sub-watersheds and the downstream point chosen as the end of the project area.

Peak flow values for the 2-year, 10-year, 25-year and 100-year storm events are summarized in **Table 9**. Hard copies of the hydrologic watershed field analysis sheets are provided in **Appendix F**. Hard copies of the computer calculation printouts of the peak flow analysis are provided in **Appendix G**.

Analysis of the hydraulic capacity of the main channel section of Porcupine Creek and the unnamed tributaries indicate that the maximum potential discharges from the proposed CBM development are much less than typical peak flows and can be transported in a stable, non-erosive manner.

FACILITY DESIGN

Discharge Structures

Discharge structures throughout the entire project area will consist of a stock water tank (tire cut in half) equipped with overflow pipe that will direct the discharge water approximately 50 feet from the tank to the actual discharge point. The discharge pipe will be stabilized with concrete, if necessary and the area immediately surrounding the discharge pipe will be covered with riprap to minimize erosion and reduce discharge velocities. A diagram of this structure is illustrated in **Figure 4**.

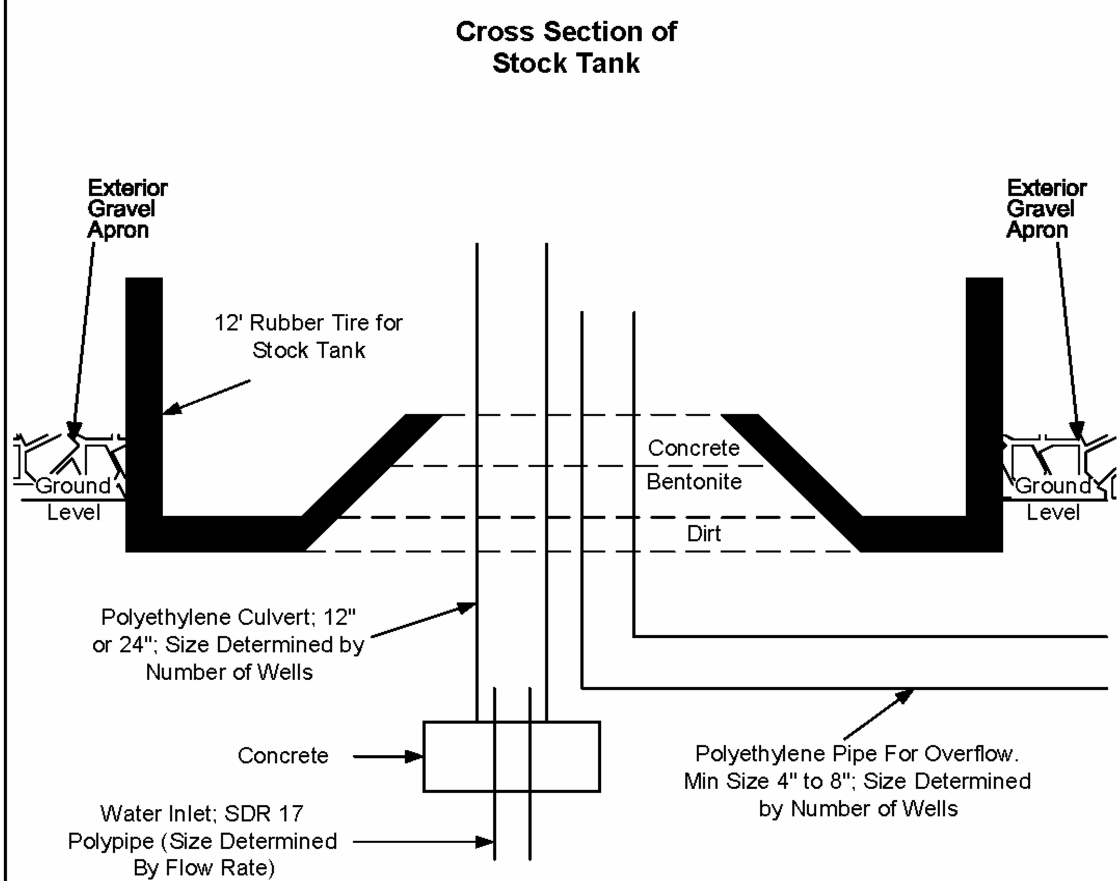
Table 9
Peak Flow Analysis

Drainage Basin	Recurrence Interval (yr)	Peak Discharge (cfs)	Runoff (in)	Time to Peak Discharge (hours)
DP-24-17-41-70	2	1.17	0.04	12.54
	5	5.68	0.15	
	10	15.50	0.28	
	25	29.50	0.45	
	50	41.96	0.60	
	100	68.95	0.91	
DP-21-21-41-70	2	0.63	0.04	12.47
	5	3.20	0.15	
	10	8.63	0.28	
	25	16.35	0.45	
	50	23.23	0.60	
	100	37.38	0.91	
DP-23-19-42-70	2	195.71	0.38	12.63
	5	333.19	0.62	
	10	520.61	0.93	
	25	633.81	1.11	
	50	841.83	1.46	
	100	1047.95	1.80	
DP-33-20-42-70	2	10.37	0.15	12.52
	5	29.81	0.30	
	10	52.88	0.48	
	25	85.86	0.75	
	50	106.92	0.90	
	100	135.43	1.10	
DP-43-28-42-70	2	10.38	0.10	12.64
	5	37.35	0.25	
	10	73.21	0.42	
	25	124.09	0.65	
	50	159.94	0.82	
	100	215.14	1.08	
DP-32-29-42-70	2	24.84	0.10	13.60
	5	82.07	0.25	
	10	155.87	0.42	
	25	258.32	0.65	
	50	334.37	0.82	
	100	448.03	1.08	
DP-11-30-42-70	2	322.25	0.38	12.00
	5	552.29	0.62	
	10	868.23	0.93	
	25	1056.25	1.11	
	50	1407.39	1.46	
	100	1757.45	1.80	
DP-41-33-42-70	2	17.21	0.20	12.95
	5	57.05	0.39	
	10	105.45	0.62	
	25	172.47	0.88	
	50	221.49	1.09	

Drainage Basin	Recurrence Interval (yr)	Peak Discharge (cfs)	Runoff (in)	Time to Peak Discharge (hours)
	100	295.23	1.40	
DP-21-2-41-71	2	11.59	0.20	13.56
	5	25.83	0.39	
	10	44.49	0.62	
	25	65.58	0.88	
	50	84.24	1.09	
	100	112.06	1.40	
DP-34-2-41-71	2	29.67	0.22	12.48
	5	66.50	0.42	
	10	103.44	0.63	
	25	156.45	0.92	
	50	198.94	1.15	
	100	253.97	1.42	
DP-31-11-41-71	2	6.29	0.22	12.26
	5	13.68	0.42	
	10	21.62	0.63	
	25	33.19	0.92	
	50	42.50	1.15	
	100	53.73	1.42	
DP-32-21-42-71	2	354.35	0.20	12.33
	5	844.53	0.39	
	10	1383.27	0.62	
	25	2049.97	0.88	
	50	2610.69	1.09	
	100	3490.98	1.40	
DP-24-23-42-71	2	56.76	0.20	13.35
	5	132.35	0.39	
	10	218.05	0.62	
	25	320.35	0.88	
	50	410.24	1.09	
	100	535.56	1.40	
DP-22-26-42-71	2	73.72	0.22	12.58
	5	169.26	0.42	
	10	275.70	0.63	
	25	406.75	0.92	
	50	521.01	1.15	
	100	677.46	1.42	
DP-24-26-42-71	2	700.25	0.36	17.52
	5	1498.18	0.59	
	10	2534.77	0.90	
	25	3633.95	1.09	
	50	4756.66	1.42	
	100	6275.26	1.75	
DP-34-26-42-71	2	750.74	0.20	18.72
	5	1619.22	0.39	
	10	2736.98	0.62	
	25	3930.19	0.88	
	50	5135.07	1.09	
	100	6776.01	1.40	
DP-31-27-42-71	2	391.54	0.08	

Drainage Basin	Recurrence Interval (yr)	Peak Discharge (cfs)	Runoff (in)	Time to Peak Discharge (hours)
	5	955.23	0.20	
	10	1631.24	0.40	
	25	2448.49	0.60	
	50	3152.90	0.79	
	100	4225.59	1.05	
DP-33-28-42-71	2	10.00	0.15	12.57
	5	27.68	0.30	
	10	50.15	0.48	
	25	81.70	0.75	
	50	100.04	0.90	
	100	124.71	1.10	
DP-22-33-42-71	2	16.17	0.15	12.57
	5	44.75	0.30	
	10	81.08	0.48	
	25	129.38	0.75	
	50	161.73	0.90	
	100	201.62	1.10	
Porcupine Creek *	2	683.94	0.10	31.54
	5	1533.43	0.25	
	10	2610.85	0.42	
	25	3871.80	0.65	
	50	5117.09	0.82	
	100	6719.82	1.08	

Porcupine Creek analysis is for the length from the confluence of Cripple Creek, S18, T42N, R72W down to the north edge Sec. 21, T41N, R70W.



Independent Production Company

Figure 4 - Stock Watering Tank Design
Independent Production Company Inc.
Big Porcupine Area CBM Project

Date: 11/18/02 **File Name: XSEC-TANK**

Reservoirs

IPC will discharge CBM water to six reservoirs that are not operated by NARC mine. These reservoirs will primarily be used by landowners for stock watering purposes. **Table 10** lists the reservoirs by location, their estimated capacity and planned modifications, upgrades, or required maintenance. **Appendix I** contains figures illustrating the details of each reservoir. All the stock watering reservoirs will be upgraded to satisfy WSEO design requirements and be permitted as required through WDEQ, WSEO and WOGCC (Dilts, 2002a; Powder River Coal Company, 2002; Putnam, 2002).

Table 10
Big Porcupine Project Reservoirs

Reservoir Name / Location	Area (acres)	Maximum Water Depth	Capacity (acre-feet)	Planned Upgrades / Repairs / Maintenance
Res34-28-42-71 SWSE 1/4 Section 28 T42N, R71W	.25	6'	1.5	Increase dam height to 12'. Maintain embankment slopes. Install 12" outlet pipe. Improve spillway. Install inline flow control structure.
Res22-33-42-71 SENW 1/4 Section 33 T42N, R71W	.30	6'	1.8	Increase dam height to 12'. Maintain embankment slopes. Improve spill way. Install 12" outlet pipe. Maintain dam embankment width. Add erosion protection. Install inline flow control structure.
Res21-02-41-71 NENW 1/4 Section 2 T41N, R71W	.60	7'	4.2	Repair dam face water side so a 3:1 slope is maintained. Repair erosion damage. Add culvert overflow. Add 12" outlet pipe. Add emergency overflow. Add erosion protection. Increase top dam width. Install inline flow control structure.
Res44-02-41-71 SESE 1/4 Section 2 T41N, R71W	.60	9'	5.4	Closed reservoir. Increase dam embankment width. Increase dam height. Maintain embankment slopes. Seal reservoir with bentonite to minimize impacts to coal mine.
Res31-20-41-70 NWNE 1/4 Section 20 T41N, R70W	.90	6'	5.4	Remove silt and sediment. Increase top of dam embankment width. Maintain embankment slopes. Add 12" outlet pipe. Add erosion protection. Install inline flow control structure.
Res21-20-41-70 NENW 1/4 Section 20 T41N, R70W	.25	7'	1.8	Remove silt. Increase dam height. Install 12" outlet pipe. Add erosion protection. Maintain embankment slopes. Install inline flow control structure.

Each of the reservoirs listed in **Table 10** will be equipped with a flow control device to allow passage of natural runoff through the reservoir. IPC will monitor the reservoirs frequently to insure that natural runoff is not captured by these impoundments.

The majority of discharges identified in the project area naturally flow to or will be pumped to numerous reservoirs designed by the NARC coal mine to collect water for use in their mining operations. These reservoirs have been permitted, as necessary by the WSEO, USACOE and other agencies. They also have been designed to handle projected CBM flows and 100 year storm events. The major reservoirs were previously described and listed in **Table 3.**

Culverts and Low Water Crossings

Drainage features will include either appropriately hardened low water crossings or culverts designed to pass the maximum expected 10 year storm flow. Low water crossings will be placed in low lying areas where project roads will be constructed. Low water crossings will be excavated 12 ins. deep by a minimum of 12 ft. wide and banks will be lowered per Gold Book standards (BLM, 1989) and Forest Service specifications. The cut will be filled with 4-6 in. hard rock (not scoria) and topped with smaller gravel. Geofabric covering will not be used. Culverts will be constructed of corrugated pipe of minimal 18 in. diameter.

Culverts and low water crossing locations have been identified based upon onsite inspections, topographic maps, discharge point locations, and proposed and existing road locations. A number of culvert locations were changed to low water crossings at the request of the Forest Service during onsite inspections conducted in June and August, 2002. The culverts and low water crossing are listed in **Table 11**. The anticipated quantity and culvert sizes have also been included in the table.

Table 11
List of Culverts and Low Water Crossings

Culvert ID	Sec.	Town.	Range	Lat.	Long.	Size (in.)	Quantity/Notes
Cul 44-28-42-70	28	42N	70W	43.57937	-105.26753	30	1 Existing/county road
Cul 24-29-42-70	29	42N	70W	43.57770	-105.29543	18	Drains small upland area under 2 track -
Cul 21-2-41-71	2	41N	71W	43.56338	-105.35575	30	1 Existing/county road
Cul 42-21-42-71	21	42N	71W	43.60160	-105.38417	36	2 Existing
Cul 14-25-42-71	25	42N	71W	43.57990	-105.34030	9	2 Existing/county road
Cul 13-26-42-71	26	42N	71W	43.58357	-105.36192	60	1-78" or 2-60" Located within flood control reservoir

Culvert ID	Sec.	Town.	Range	Lat.	Long.	Size (in.)	Quantity/Notes
Low Water Crossings ID							
LWC 21-23-42-71	23	42N	71W	43.60556	-105.35470		
LWC 23-23-42-71	23	42N	71W	43.59644	-105.35363		
LWC 44-23-42-71	23	42N	71W	43.59349	-105.34399		
LWC 33-26-42-71	26	42N	71W	43.58334	-105.34738		
LWC 21-27-42-71 (A)***	27	42N	71W	43.59182	-105.37316		
LWC 21-27-42-71 (B)	27	42N	71W	43.59052	-105.37402		
LWC 22-27-42-71	27	42N	71W	43.58773	-105.37284		
LWC 24-28-42-71	28	42N	71W	43.57804	-105.39241		
LWC 44-28-42-71 (A)	28	42N	71W	43.57985	-105.38531		
LWC 44-28-42-71 (B)	28	42N	71W	43.57783	-105.38241		
LWC 31-27-42-71	27	42N	71W	43.58890	-105.37005		
LWC 23-35-42-71	35	42N	71W	43.56994	-105.35483		

Cul Culvert
LWC Low Water Crossing
*** Only Constructed if IPC can not use existing road thru archaeological site.

The culvert sizes equal or exceed 18 inches diameter, will be constructed of corrugated pipe, and were sized to ensure they satisfy BLM requirements (BLM, 1996?). Each culvert is designed to pass a 10-year flood without development of static head at the entrance. The roadway grade and culvert sizing will be balanced to avoid serious head and velocity damage for 25-year floods. Culverts will be buried to a minimal depth of 1 ft. Downstream ends will be appropriately armored with rip rap.

WATER WELL AGREEMENTS

IPC certifies that it has reached water well impairment agreements with private landowners in the area of the Big Porcupine project. IPC has not reached such an agreement with Powder River Coal Company, since their mutual objective is to dewater the target coal seams. Neither has IPC reached such an agreement with the Forest Service.

For those instances where a water well impairment agreement has not been reached, IPC agrees to mitigate the impacts of its coalbed methane wells in accordance with Wyoming state water laws. A listing of active domestic and stock watering wells (as of 10/2002) within one mile of the project area is indicated in **Appendix H**.

DOWNSTREAM IMPACTS

Adverse downstream impacts from the Big Porcupine Project are not anticipated. All of the produced CBM water is expected to be contained within the NARC coal mine for various industrial uses. A detailed water balance done for this study indicates the low probability of any water being discharged outside of the control of the mine. It is possible that the availability of CBM water will permit the mine to resume periodic discharges from the Railroad Loop Reservoir to Porcupine Creek for the benefit of landowners downstream.

The high quality of discharge water and its dominant use for industrial purposes suggest that water quality impacts are not a concern. Six reservoirs will be permitted and upgraded for limited storage of CBM water. These impoundments will be of beneficial use to local landowners for stock watering purposes and for wildlife.

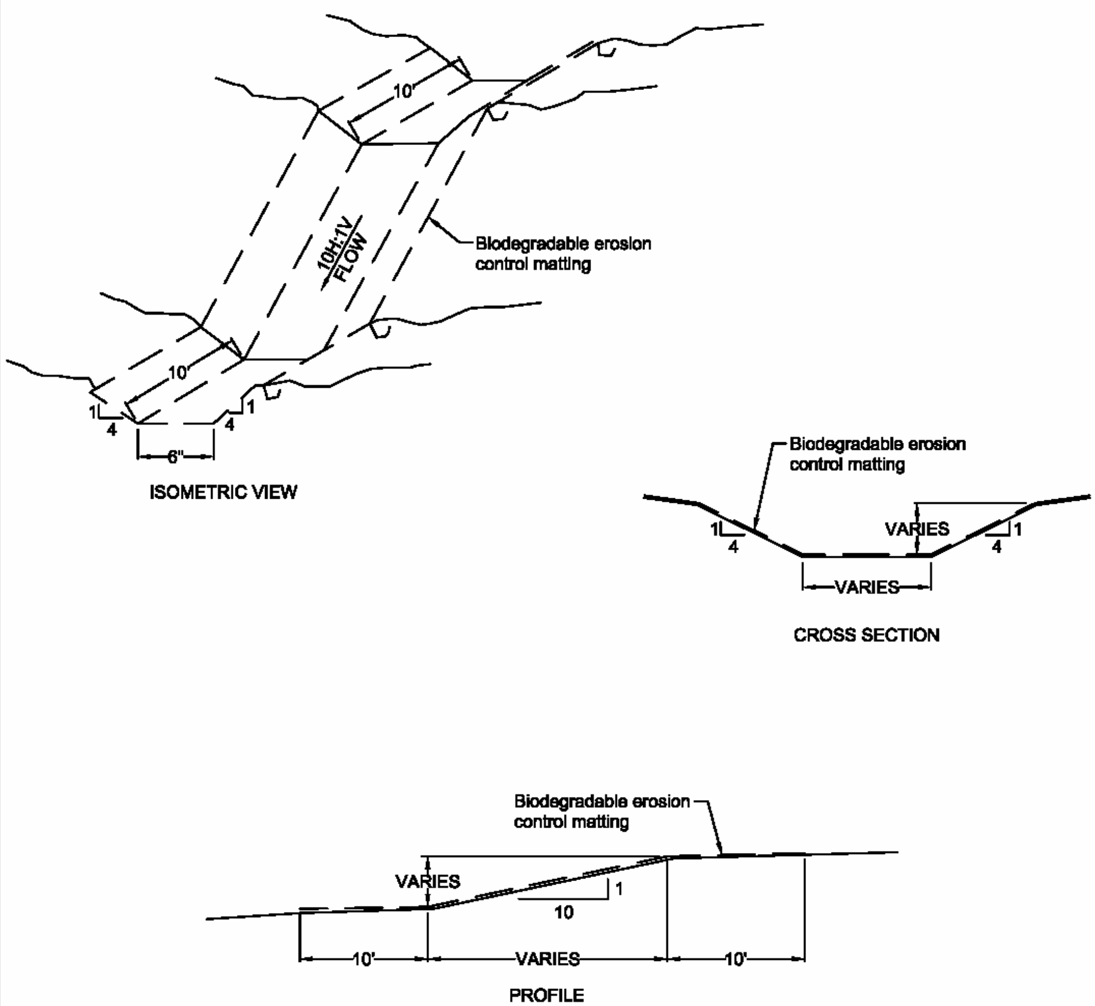
Sediment Control

The release of significant volumes of water to local ephemeral drainages raises concerns regarding an increase in channel erosion and increase in downstream sediment deposition. During examinations of the channels, headcutting was observed occasionally and a significant series of headcuts was noted in an unnamed Porcupine Creek tributary in Section 27 T42N, R71W.

Significant downstream erosive impacts are not expected for the following reasons:

- All of the CBM discharge will be trapped in mine reservoirs in the immediate vicinity of the project area and the system of reservoirs will remove sediment from CBM water prior to storage and use.
- Volumes of CBM discharge are very low compared to storm events.
- The volume of produced water is rapidly reduced due to conveyance losses.
- Most channels are moderately to heavily vegetated which helps reduce erosion under low flow situations.
- In areas of extensive headcutting, scour pools act as in-channel sediment traps.
- Within 5-20 years, the vast majority of the project area is expected to be mined and reclaimed. Active coal mines are operating to the east and south of the project area.

On Forest Service surface, headcuts will be remediated by sloping the headcut back from its base at a ten times horizontal vs. vertical slope or flatter. Sides of the headcut will be sloped at a four times horizontal vs. vertical slope, or flatter. The modified area will be covered with a biodegradable erosion control fabric. A diagram indicating headcut mitigation is illustrated in **Figure 5**.



Independent Production Company

Figure 5 - Headcut Remediation Plan
Independent Production Company Inc.
Big Porcupine Area CBM Project

Date: 11/18/02 File Name: HEADCUT

IPC has been refused permission to perform mitigation to three headcuts located on private surface in Sections 21 and 28, T42N, R71W (Dilts, 2000). IPC agrees that, in the event sedimentation resulting from CBM discharge over these headcuts causes damage to Forest Service land, IPC will mitigate any such damage. The location of mapped headcuts is illustrated on the **Project Map.**

Berms

A number of dry dams, or berms, are found in the project area, mostly on private surface. These berms appear to have been constructed decades ago to slow natural runoff from storms. They have never been permitted through the WSEO. Where CBM water is being discharged above such berms, impoundment of the water behind the dam is a violation of WSEO regulations.

IPC has reached agreement with private surface owners regarding upgrading and permitting or breaching berms to achieve compliance with WSEO requirements (Dilts, 2002a; Independent Production Company/Powder River Coal Company, 2002). Berms which are not being upgraded and permitted for use as stock reservoirs will be breached to avoid impoundment of CBM produced water. A similar agreement has not yet been reached with the Forest Service with respect to a berm in Section 35, T42N, R71W.

MONITORING AND MITIGATION

Each discharge point will be monitored on a monthly basis and all dam outlets (spillways and low-level pipe outlets) culverts, and low water crossings will be checked quarterly and after major storm events. In addition, the channel section below each reservoir will be inspected for signs of overtopping and/or seepage. Inspectors will note the condition of all reservoirs and discharge points, check for evidence or erosion or failure. As conditions are identified that require repair, the appropriate remedial work required will be scheduled and performed. If erosion is noted, it will be mitigated with erosion control measures, modification of discharge structures or locations, and if necessary diversion of discharges to other locations. After the first year of operation, inspections will only occur annually unless site specific concerns are identified. Culverts and low water crossings will be inspected after major storm events. Debris will be removed to prevent culvert blockage and repairs will be made as necessary.

Headcuts located on private surface where the landowner has denied permission to mitigate will be monitored. For each identified headcut, a five foot length of 3/8 inch rebar will be pounded three feet into the ground at a measured location six feet upstream of the most upstream portion of the headcut. During the first year after onset of production of CBM water, headcuts will be monitored by IPC personnel on a monthly basis, and semi-annually in subsequent years. Monitoring will also be performed after major storm events. Monitoring will also be conducted semi-annually by Forest Service personnel.

Regulations of the WSEO require that CBM discharge reservoirs built or upgraded for the project be designed so as to capture only that natural flow exceeding the annual peak runoff event. In lieu of installing self-regulating runoff bypass facilities, IPC proposes the installation of a manually adjustable flow control gate. The gate height will be set so as to match the water level of CBM discharge for each reservoir. Reservoir levels will be monitored at least weekly by an IPC employee to insure that the gate height does not exceed the CBM discharge level. As CBM discharge declines, and water levels in the reservoirs drop, the gate height will be lowered to continue to match the level of CBM-derived reservoir water.

Long term mitigation of the project area will be addressed by the local surface coal mines. The majority of the project area will be consumed by the coal mines within twenty years if current mining rates remain constant (5 years per mile or 100 million tons annually). Portions of the project site will be mined much earlier (five to eight years), as the coal mine is less than two miles from the proposed production area. Once the coal is removed from these areas they will be reclaimed and rehabilitated.

LESSEES' OR OPERATOR'S REPRESENTATIVE CERTIFICATION

I hereby certify that I, or persons under my direct supervision, have inspected the watershed area(s) affected by our coal bed methane drilling and production plans; that I am familiar with the conditions which currently exist; that the statements made in this plan are, to the best of my knowledge, true and correct; and that the work associated with operations proposed herein will be performed by Independent Production Company, Inc. or its assignee and its contractors and subcontractors in conformity with this plan and the terms and conditions under which it is approved. This statement is subject to the provisions of 18 U.S. C. 1001 for the filing of a false statement.

*Date*_______________________________

*Name and Title*____

REFERENCES

Beels, Paul, 2002, Personal communication with Paul Beels, Project Manager, Bureau of Land Management, Buffalo, WY.

Bureau of Land Management and USDA Forest Service Rocky Mountain Regional Coordinating Committee, 1989, Surface Operating Standards for Oil and Gas Exploration and Development, Third Edition (Gold Book).

Bureau of Land Management, 1996?, Engineering : Road Standards : Excerpts from BLM Manual, Section 9113, U. S. Dept. of the Interior, Washington, DC.

Bureau of Land Management, 1999, Wyodak Coal Bed Methane Project Final Environmental Impact Statement, Cheyenne, WY.

Bureau of Land Management, 2000, Wyodak Drainage Coal Bed Methane Environmental Assessment, Cheyenne, WY.

Bureau of Land Management, 2002, Powder River Basin Oil and Gas Project Draft Environmental Impact Statement, Cheyenne, WY.

Day, Mike, 2002, Personal communication with Mike Day, Hydrologist, Applied Hydrology and Associates, Denver, CO.

Dilts, Jerry, 2002, Letter Denial of Surface Modification and Access Request, Jerry J. Dilts et ux. Family Ltd. Partnership and Bridle Bit Ranch Co., 6546 S. Douglas Highway, Gillette, WY 82718.

Dilts, Jerry, 2002a, Agreement with Respect to Permitting and Modification of Existing Stock Ponds, Jerry J. Dilts et ux Family Ltd. Partnership and Bridle Bit Ranch Co., 6546 S. Douglas Highway, Gillette, WY 82718.

Eastern Research Group, 2002, Coal Bed Methane Producers Information Survey Results, Chantilly, VA

Independent Production Company/Powder River Coal Company, 2002, Agreement with Respect to Disposition of Produced Water, Surface Modification, and Modification of Existing Ponds Effective 12/15/02, Independent Production Company, 410 17th Street, Suite 570, Denver, Colorado 80202.

Meyer, Joe, 2000, Belle Fourche River Basin 1993 to 1999, Memo to File, November 2, 2000, Bureau of Land Management, Casper, WY.

Meyer, Joe, 2002, CBM water recharging aquifers faster than expected, quoted in Casper Star Tribune article, July 8, 2002, Casper, WY.

Murphree, Philip, 2002a, Personal communication with Philip Murphree, Mine Hydrologist, North Antelope/Rochelle Complex Coal Mine, Gillette, WY.

Murphree, Philip, 2002b, Utilization of Water Produced from Coal Bed Methane Operations at the North Antelope/Rochelle Complex, Campbell County, Wyoming, in preparation, 2002 Ground Water Protection Council Produced Water Conference, Colorado Springs, CO.

National Oceanic and Atmospheric Administration, Precipitation Frequency Atlas of the Western United States, Volume II - Wyoming, 1973.

North Antelope/Rochelle Complex Coal Mine, 2002, North Antelope/Rochelle Water Management, Gillette, WY, 7 pgs.

Putnam, Harry, 2002, Agreement with Respect to Permitting and Modification of Existing Stock Ponds, Putnam Family Trust, P. O. Box 568, Wright, WY 82732.

USDA Soil Conservation Service, 1984, Engineering Field Manual for Conservation Practices, EFM1.

USDA Soil Conservation Service and University of Wyoming Agricultural Experiment Station Campbell County, 1955, Wyoming Soil Survey, Series 1939, No. 22.

Viessman, Warren et al, 1977, Introduction to Hydrology, Second Edition, Harper & Row